What are pathogens?

Waterborne human pathogens are disease-causing bacteria, viruses, and protozoa. The pathogens that are of concern in Vermont surface waters are those that come from fecal matter of humans and other warm-blooded animals. These pathogens may cause gastrointestinal problems and pose a more serious health risk to people who have weakened immune systems. Untreated surface waters containing fecal matter may pose a risk to human health when ingested through drinking water or inadvertently through contact recreation.

The primary indicator of fecal material in water used in most freshwater monitoring efforts is the enteric bacterium *Escherichia coli*. *E. coli* is a common component of the bacterial flora of humans and other warm-blooded animals. When detected in rivers, lakes, ponds, streams, or drinking water, *E. coli* may indicate that fecal material has made its way into the water. *E. coli* is therefore used as an indicator of potential fecal contamination of the water. *E. coli* are pathogenic in and of themselves, but the presence of *E. coli* is used in monitoring programs to indicate that other more common fecal pathogens may also be present, including pathogenic viruses, protozoa, or bacteria. While water contaminated with fecal material may contain pathogens, these pathogens may not survive outside the intestines for long periods of time and therefore may not stay alive in the water (Schaechter, 1992).

Based on epidemiological studies, the risk of contracting a gastrointestinal illness from swimming in water contaminated with a given concentration of indicator bacteria can be estimated. Vermont's water quality criterion for *E. coli* bacteria for Class B waters is 77 *E. coli*/100 ml in a single sample. This is the most stringent standard in the United States. This conservative standard of protection is readily exceeded due to natural *E. coli* sources, (*e.g.*, wildlife, run-off) that do not reflect the same risk level as those identified in the above mentioned epidemiological studies. In order to assess waters for support of contact recreation using *E. coli* monitoring data, DEC considers at least five reliable and quality assured sample results over a swimming season and gathered across a range of weather/flow conditions to be the minimum practical number of samples necessary.

Groups of Pathogens:

Bacteria: *The waterborne zoonotic bacteria are principally those shed in feces by warm-blooded animals (birds and mammals), including Escherichia coli or E. coli.*

Viruses: *Viruses are tiny infectious agents consisting of genetic material (DNA or RNA) encapsulated by a protein coat and incapable of multiplying outside the host, but often associated with larger particles in the water environment.*

Protozoa: *Protozoan pathogens, including microsporidia, amoebae, ciliates, flagellates, and apicomplexans, originating in human or animal feces, have been found in surface waters worldwide.*

Emerging or Re-emerging Infectious Disease: *A disease whose incidence has increased in recent years or is expected to increase in the near future. Primary amoebic meningoencephalitis (PAM) caused by Naegleria fowleri is an example of an emerging waterborne infectious disease in the United States*

How important are Pathogens?

Based on the Watershed Management Division's stressor evaluation, pathogenic bacteria is considered a lower-ranked stressor (in relation to the other 10 priority stressors), in that known affected areas are discrete and effects typically localized, and when addressed, impacts are rapidly mitigated. However, where pathogens are regularly monitored and found to be chronic in frequency and excessive in numbers, swimming and other contact recreation use is affected.

The extensiveness of pathogenic impacts varies depending on geographic location and also on precipitation. For example, *E. coli* may be widely detectable in surface waters following a significant rain event, particularly in agriculturally-dominated watersheds. Conversely, in forested watersheds during low flow, low concentrations of *E. coli* are noted. However, events in the absence of both land use and climatological influences can cause exceedences in *E. coli*, such as improper waste water treatment from facilities or septic systems.

The most recent statewide water quality assessment indicates that nearly 100 stream miles are identified as impaired due to pathogens indicated by *E. coli*, and contamination in Vermont's waters continues to be a problem across the state. Over 20% of the waterbodies identified on the 2008 303(d) List of Impaired Waters has been listed because of elevated *E. coli* concentrations. The incidence of excessive *E. coli* concentrations is most prevalent in rivers and streams. Available monitoring data indicate that very few lakes and ponds exhibit high *E. coli* concentrations. The Watershed Management Division is currently investigating potential methodologies to develop Total Maximum Daily Load pollution control plans for these waters. While TMDL development, or identification of the total loading limits of *E. col*i for these impairments is a relatively simple exercise, the main focus of the TMDL needs to be identification of *E. coli* sources and strategies for their elimination.

Source identification ranges from very basic to technically advanced techniques and multiple methods may be necessary to pinpoint sources. Vermont DEC has recently teamed with the USGS and undertaken a feasibility study to develop TMDLs using genetic markers. Two impaired reaches within the Huntington and Mettowee watersheds were selected for pilot investigations since each had several years of *E. coli* monitoring data and primary sources were believed to be different based on varying land uses. Samples were collected during storms and base flow conditions and analyzed for genetic markers to identify human, ruminant and dog as potential sources of fecal contamination. Results from the study are still pending but promising as this powerful method could be added to the arsenal of source identification techniques. The Division is also working with USEPA contractors to develop TMDL's based on a method developed in the state of New Hampshire.

The duration or fate of pathogens in the environment tends to be relatively short-lived. However, where sequestered in soils and sediments, *E. coli* bacteria can be mobilized during periods of land and streambank erosion and can enter surface waters. It is unclear whether other pathogens that may be indicated by *E. coli* can also survive in soils and sediments. Specifically, while *E. coli* can survive and reproduce with or without oxygen, *bacteroidales*, the bacteria that were used for the genetic marker testing, cannot survive in the presence of oxygen. This difference in survivability between these two species of bacteria complicates the understanding of the fate and transport of legacy bacteria.

Generally, the more sediment runoff, the more potential for transport of *E. coli* bacteria. Controlling sediment runoff on tributaries as well as mainstem streams can certainly go a long way towards decreasing concentrations of many pollutants, including nutrients, metals, and bacteria in streams. In addition, there could be some legacy amounts of these constituents stored in streambank or streambed sediments that can be cycled back into the water column, but these sources are difficult to parse out in conventional water quality monitoring of pathogens.

The current Vermont criterion for *E. coli* in Class B swim waters is 77 organisms/100 ml of water for any single sample. This criterion was developed in the 1990s as an erroneous interpretation of now outdated EPA guidance, which suggested that such a criterion would protect swimmers to somewhat less than 4 expected illnesses per 1000 swimmers. This criterion is significantly more stringent than the current EPA recommended recreational water quality standard for *E. coli* of 235 organisms/100 ml for any single water sample, which literature indicates corresponds to a risk of approximately 8 gastrointestinal illnesses per 1000 swimmers who frequent beaches adjacent to municipally-discharged wastes subject to minimal treatment. The current water quality criterion, when applied to guide beach closures, results in inaccurate public opinions about the suitability of surface waters for swimming, as is discussed fully in the Division's Citizens Guide to Bacteria Monitoring in Vermont. Other restrictions on bathing areas in Vermont have recently included beach closures due to cyanobacteria blooms and animal fecal waste (e.g. geese and gulls defecating along shoreline), which can be a source of *E. coli* contamination. The reader is cautioned that the occurrence of a beach closure should not be equated with the determination that the beach is polluted due to pathogens.

Objectives achieved by controlling excessive pathogenic bacteria

Addressing and preventing excessive pathogenic bacteria promotes several surface water goals and objectives, including:

Objective A. ***Minimize Anthropogenic Nutrient and Organic Pollution***

Managing activities (land uses) and discharges in ways that minimize or eliminate sources and exposure (via contact recreation) to pathogens also minimizes anthropogenic nutrient and organic pollution.

Objective D. ***Minimize Toxic and Pathogenic Pollution, and Chemicals of Emerging Concern***

Controlling the release of pathogens minimizes human exposure to pathogens.

What are the causes and sources of Pathogens?

Untreated/unmanaged Runoff from Developed Lands

Overland flow

Urban stormwater runoff occurs when precipitation collects and then runs off impervious surfaces, often directly into streams, rather than infiltrating into the soil. Stormwater in urban areas carries a significant load of pollutants to receiving water bodies. Concentrated activity in urban areas loads stormwater with fertilizers, road salt, animal feces, pesticides, oils, heavy metals, and decaying organic matter.

The bigger issue may be the changes in hydrology that occur in developed areas. Much of urban development involves the construction of buildings, roadways and parking – all of which create impervious surface, that both reduce infiltration and can speed the delivery of stormwater runoff to local receiving waters. These increases in stormwater runoff volume and rate (referred to collectively as "excess hydrology") can, in turn, increase rates of export of pollutants including sediment and sediment-bound phosphorus and other pollutants such as pathogens.

The end result of unmanaged stormwater can include the erosion of valuable property, degraded or destroyed aquatic life and wildlife habitats, algal blooms and pathogen contaminated beaches and water supplies.

Combined Sewer Overflows

In several of Vermont's larger communities served by Wastewater Treatment Facilities, combined sewer overflows (CSO's) represent an ongoing nonpoint source pollution problem. Strong state and federal standards are used in obtaining stormwater and or wastewater treatment permits. The standard used by Vermont for remediation for remediation of combined sewer overflows is to separate stormwater volumes from wastewater and to provide an acceptable level of treatment. Stormwater procedures encourage the use of overland flow and the attenuation of peak discharges and velocities.

Pet Wastes
In developed residential areas adjacent to surface waters, pet wastes can be a considerable source of *E. coli* bacteria and potential pathogens.

Agricultural activities

Agriculture has been identified as a contributor to surface water pollution in Vermont. While significant strides have been made to reduce agricultural nonpoint source pollution through the voluntary implementation of soil and manure management practices, agriculture remains one of the most significant potential sources of nonpoint source pollution. Inadequate animal waste and soil management results potential pathogen loading to surface waters and is the major source of agricultural nonpoint source pollution in the State. The following sources are described in Appendix C – Activities.

Farmsteads
Pastures
Cropland

Untreated or Improperly Treated Wastewater

On-site Septic Loads
Inadequate on-site septic systems can be a source of pathogens to surface waters. There are a number of historic villages in the state adjacent to rivers that do not have treatment facilities and where on-site septic systems are likely the source of elevated levels of E. *coli* in surface water. If a system is not working correctly and leachate is directly entering a lake, swimmers and other forms of contact recreation may expose users to high bacteria levels and potentially disease-causing organisms. (Note that such a system may not show any on-shore indications of malfunction.) This can happen under several conditions including when the soil below the leachfield is too shallow or too porous and leachate quickly joins the groundwater. Along a lakeshore groundwater is usually flowing toward the lake and entering the lake water through the lakebed.

DEC provides direct funding and technical assistance to small communities without sewers to help them evaluate and plan for their wastewater needs. It is anticipated there will be a steady demand by several small communities for wastewater evaluations and planning in the coming years. These communities have not been identified in the past as being the sources of surface water pollution, but residents are now realizing that they may have problems with their small lot and older on-site sewage systems. Another factor is the economic viability of small communities which cannot have commercial or residential growth due to limiting soil conditions for septic system leachfields. During 2009, the towns of Addison and Peacham began such studies for their village centers.

Wastewater Treatment Facility Loads
Unlike nearly all of the other sources described in this chapter, wastewater discharges represent a regulated and readily measurable and controlled source of pathogens to waters in the state. There 91

municipal wastewater facilities statewide, and 81 industrial facilities all of which are subject to permit requirements requiring effluent limitations on *E. coli* at 77 *E. coli* /100ml.

Natural Sources

While forested watersheds generally have better bacterial water quality than that of other land uses (Kunkle and Meiman 1967, Kunkle 1970, Skinner et al. 1974, Doran and Linn 1979, Tiedmann et al. 1987, Niemi and Niemi 1991, Sargent 2001), these watersheds can nevertheless be important contributors to bacterial contamination downstream, due to wildlife sources. Several studies have documented the existence of indicator bacteria in "pristine" environments, even under non-storm conditions. Morrison and Fair (1966) reported coliform bacteria in "clean" streams in Colorado. Early studies by Kunkle and Meiman (1967) and Skinner et al. (1974) of natural areas essentially free of human impact consistently identified fecal coliforms, at low concentrations, although results were. much higher during non-storm events. A study of 3 small watersheds in Utah that had been protected from fire, domestic livestock, and timber cutting for 45 years yielded fecal coliform concentrations that ranged to maxima of 183 organisms/100 mL (Doty and Hookano, 1974). Ongerth et al. (1995) documented levels of fecal coliform higher than 100 organisms/100 mL in a pristine forested watershed, while Tiedmann et al. (1987) reported fecal coliforms in excess of 500 organisms/100 mL in forested areas of eastern Oregon that supported no domestic grazing. Recent local studies (Sergeant and Morrissey, 2000; Moir, 2003) tell us that under moderate rainfall, *E. coli* will be found in waters running off of completely undisturbed, forested watersheds at levels in excess of 77 E. coli /100ml, the current water quality criterion for Class B waters in Vermont.

Land use and pathogens:
Most studies quantifying the relationship between land use and water quality have been focused on sediment and nutrient loading, particularly phosphorus and nitrogen, and contamination by metals or toxic chemicals, but the spatial framework also applies to the study of bacterial water quality. Since watersheds integrate surface and subsurface flow of water above a sample point, they are appropriate spatial units for the study of nonpoint source stream pollutants like fecal bacteria (Omernik and Bailey, 1997). Cumulative impact studies have compared changes in water quality to changes in land use by locating sampling stations consecutively downstream. In the Appalachian Mountains of North Carolina, fecal coliform counts increased downstream as land use changed from forested to suburban (Bolstad and Swank, 1997). In a comparison of stream fecal coliform concentrations monitored above and below rural municipalities, the municipalities were found to contribute a significant amount of fecal bacteria to surface waters (Farrell-Poe et al., 1997). In contrast, Sargent (2001) found no difference between *E. coli* measurements above and below a Vermont village. However, she did find a significant negative relationship between watershed forest cover and *E. coli* concentrations in streams in the Mad River valley. Relating bacterial levels in streams to land use can be improved by aggregating and analyzing data within watersheds and drainage areas.

Streambed sediments as a reservoir of fecal bacteria:
Studies measuring the amount of bacteria found in streambed sediments and comparing it with levels in the overlying water column have documented that streambed sediments represent a significant reservoir of fecal bacteria. The phenomenon of deposition was demonstrated by a dye study conducted by Gannon et al. (1983), in which fecal coliform concentrations in bottom sediments were shown to increase in an upper area of the study lake while fecal coliforms in the water column were decreasing simultaneously. Gannon concluded that sedimentation of fecal coliforms attached to solid particles accounted for the high fecal coliform disappearance in that area of the lake. Van Donsel and Geldreich (1971) discovered approximately a 100-1000 fold increase in fecal coliforms in stream

sediments as compared to the overlying water. Stephenson and Rychert (1982) confirmed this finding with their own observations that E. coli concentrations in bottom sediment were 20-760 times that of the water. Both Crabill et al. (1999) and Buckley et al. (1998) observed fecal coliform sediment to water ratios of greater than 2000:1. There have also been several studies that did not directly sample the sediment, but instead used disturbance methods like raking to simulate the resuspension of the sediment and its associated bacteria such as would occur during recreational use or high stream flows. Sherer et al. (1988) found that manual disturbance of stream bottom sediments increased bacterial water concentrations an average of 17.5 times. Moir and Morrissey (in prep.) found that high storm flows are particularly effective in resuspending most of the fecal- bound sediments during a storm event. Thus recontamination of surface water can occur long after and at a considerable distance from the point of original fecal input to the stream.

Monitoring and Assessment Activities that Address Pathogens

Ambient Water Quality Monitoring Program Strategy

The Vermont ambient water quality monitoring program strategy provides a framework describing existing monitoring and assessment efforts in Vermont, and elaborates on elements of an ideal monitoring program to meet several objectives. The strategy has multiple uses and purposes, and is organized into USEPA's "Elements of a State Water Monitoring and Assessment Program" (March, 2003). This strategy presents a roster of specific monitoring goals and objectives, and a listing of existing and potential monitoring designs for Vermont waters. Recommendations for core and supplemental water quality indicators are provided (including pathogens). Detail is provided on quality control and assurance, data management approaches, a description of data analysis and assessment procedures, and the use of these procedures to support federally required reporting. The strategy also highlights approaches to developing nutrient criteria and modifying pathogen criteria.

LaRosa Laboratory Services Partnership Program

The VTDEC Watershed Management Division collaborates with the LaRosa Laboratory on a novel program to assist citizen monitoring groups statewide. Beginning in 2003, the Watershed Management Division and LaRosa Laboratory initiated analytical services partnerships with volunteer organizations, based on a competitive proposal process. The project has been extremely successful since its inception, when eleven projects were supported. These projects ranged in scope from small, single-lake studies to large, multi-year and multi-parameter watershed assessment initiatives that have included monitoring for pathogens.

Spotlight on Volunteer Monitoring

The Addison County Collaborative (ACC) is a volunteer-based consortium of local volunteer organizations that monitor waters in several watersheds in the vicinity of Addison County. Funding is typically allocated through the Addison County Regional Planning Commission and by member municipalities, with laboratory support from the LaRosa Partnership Program. ACC has monitored approximately 45 sites across several watersheds for *E. coli* and eutrophication-related parameters since 1992. ACC provides data and summary reports to VTDEC on an annual basis. These data are used to assist development and implementation of the Otter Creek and Lower Direct Champlain Basin Plans, and in Integrated Assessment reporting. ACC has provided valuable data in support of municipalities, and Division data needs. Several other LaRosa Partnership-supported groups support similar monitoring throughout Vermont.

Department of Forests, Parks and Recreation Monitoring

The Department of Forests, Parks and Recreation conducts weekly monitoring of E. coli indicator bacteria at all Vermont State Park beaches to post beaches when appropriate. The Division collects and stores these data annually to support individual surface water assessments.

Sanitary Surveys

A common perception in Vermont is that failing septic systems are a large source of fecal material, particularly to lakes. Determining the potential contribution of potentially failing septic systems is a tricky proposition, and is known as a 'sanitary survey.' Historically, testing of septic systems was accomplished using dye tablets, which were flushed down the toilet in a shoreline property with follow-up visual monitoring over the next several days to identify if and where dye may be leaching into the adjacent water. Additional information regarding sanitary surveys is also available in Chapter 4 of EPA's draft Ambient Water Quality Criteria for Bacteria (Appendix G, EPA, 2002).

Microbial Source Tracking

A relatively new monitoring technique, called Microbial Source Tracking (MST), analyzes the genetic fingerprint of the *E. coli* itself, to identify the organism that produced the fecal material containing the E. coli. Currently, there are different genetic techniques and approaches being developed for this purpose. This approach is still in the developmental stage, although it is likely to be a very valuable and powerful tool for identifying fecal contamination sources in the near future.

Basic concept The intestinal bacteria of animal groups (e.g. humans, livestock, and wildlife) are expected to be different and these differences can be detected by analyzing water samples in the laboratory. The relative difference between the different animal group intestinal bacteria in the water may provide evidence to determine from where the fecal contamination originated.

The research process

→ Characterize "reference material" (manure, scat, and sewage) from local sources. Scientifically, this step involves detection of specific DNA sequences (called "markers")

→ Test water for fecal contamination, i.e. *E. coli*.

→ Associate contamination with sources by matching markers in reference material with markers in water samples.

Stormwater Modeling/ Stormwater Mapping

Stormwater sometimes follows more of a hydro-illogical pattern, depending on the construction of roads rather than natural topography. To find out the path of stormwater and the pollutants it can carry, a GPS can be used to determine the coordinates of culverts, manhole covers, storm drain inlets, and outlets. Empirical information (such as water quality data) and observations on rainy days are utilized to clarify which direction stormwater travels through ditches and gutters that eventually drain into rivers and streams.

Once the series of storm drains and gutters is mapped out, this data was used to build a drainage network in a GIS or Geographic Information System. This digital drainage network provides a better understanding of how different urban areas in the state affect adjacent surface waters. Next, monitoring equipment can be placed where the surface water connects to the stream and water samples collected. Using the GIS, monitoring equipment and water quality collection in unison will help narrow down potential sources of water pollution that are being flushed into these surface waters.

Key Monitoring and Assessment Strategies to Address Pathogens

- Integrate existing stormwater mapping, water quality data, biomonitoring data, riparian corridor assessment (SGA-buffer gap analyses) and agricultural (NRCS) flow monitoring data in Agency GIS systems to enhance river corridor protection and basin planning capabilities. This strategy would engender the establishment of a map-based reporting program that could tailor outputs to assist the technical assistance, regulatory, and funding decisions of the ANR (e.g., within the Tactical Planning process) and other agencies.

- Identify public swimming beaches at lakes and ponds (either municipal swimming areas or state parks and other public lands). Work with communities, lake and pond associations, and others who are testing for indicators of pathogens and other health threats.
- Consider development of an electronic reporting system that can enumerate *E. coli* levels at public swimming holes that are monitored. This monitoring/ reporting program is intended to be used as a reporting tool at swimming areas to post episodic increases in bacteria levels. Results from such program could be used as public notification and information for decision-making for contact recreation activities. The use of VTDEC bacteria monitoring protocols will be imperative in this process.
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Solution(s): 1) Increase pathogenic-bacteria monitoring at public swimming beaches at lakes and ponds by directing citizen groups supported through the LaRosa Partnership Program towards these areas. 2) Set up an electronic notification system for user groups and the general public to access *E. coli* monitoring results so that citizens engaged in contact recreation can make informed decisions for when and where to conduct that activity. 3) Continue to work with EPA to explore availability of federal funding mechanisms to support beach monitoring and reporting efforts.

- Through bracketed monitoring, investigate areas indicating high *E. coli* to determine the sources.

- Continue to address episodic overflows at wastewater treatment facilities where upgrades, expansion, and additional improvements are needed (such as under-sized pump stations).

Develop water quality bacteria monitoring data to better guide the assessment of pathogenic stressor impacts and the alternatives analysis for BMPs and projects to protect and restore existing uses such as swimming and other forms of contact recreation.

Technical assistance programs to address excessive Pathogens

Technical assistance to address pathogens is coordinated by VTDEC and partner organizations under the following:

Department of Environmental Conservation:
Facilities Engineering Division – Clean Water Revolving Fund
Wastewater Management Division - Design/Engineering Program
Wastewater Management Division – Operations and Management Program
Wastewater Management Division – Innovative and Alternative Systems
Watershed Management Division – Stormwater section assistance to municipalities (MS4, MSGP)
Watershed Management Division – Stormwater Mapping and Illicit Discharge Detection and Elimination Project

Agency of Agriculture, Food, and Markets

Farm Agronomic Practices (FAP)
Large Farm Operations (LFO) Program
Medium Farm Operations (MFO) Program
Conservation District Technical Assistance Program
Accepted Agricultural Practices Assistance
Farm*A*Syst
Land Treatment Planners
Farm Agronomic Practices Program (FAP)

New England Interstate Water Pollution Control Commission
Wastewater operator certification program

Vermont Rural Water Association
Training programs for wastewater and source water protection

Key Technical Assistance Strategies and Next Steps to Address Excessive Pathogens

- The technical assistance programs listed above do a good job at supporting control of excessive pathogens and should be continued. As appropriate, WSMD staff should cooperate with AAFM and NRCD programs to target technical assistance to areas where monitoring and assessment data suggest it is most highly needed.

- The addition of new agricultural extension agents in 2011 will enhance technical assistance capabilities of the conservation districts with assistance from the Lake Champlain Basin Program and UVM Extension to provide assistance and treatment designs in agricultural areas.

- Stormwater mapping and Illicit Detection and Discharge Elimination (IDDE) efforts should be continued, but coordinated as appropriate within the tactical planning process to further target municipalities where infrastructure mapping has not yet been carried out. Staff from this program work in collaboration with municipalities to design remediation steps that address the deficiencies identified.

- Encourage farmer participation in Nutrient Management Planning beyond the regulations governing Large and Medium Farm Operations.

- Buffer Outreach projects and federal cost-share programs should target sensitive riparian areas characterized by a lack of riparian vegetation that would benefit from the re-establishment of a vegetated riparian buffer. Encourage riparian landowners (and incentives, if possible) to maximize the width of buffer zones adjacent to the tributaries and the river itself.

- Assist farmers with manure storage and application practices. Help direct federal cost-share and other funding sources towards manure storage and handling improvement projects. Manure spreading close to tributaries and the river itself should be discouraged, especially in areas where the ground slopes into the water.

Regulatory programs to address Pathogens

Regulation of pathogens is coordinated by VTDEC and partner organizations under the following:

Department of Environmental Conservation:

Wastewater Management Division, National Point Source Discharge Elimination System Program
Wastewater Management Division, Vermont Indirect Discharge Permits
Wastewater Management Division, Residual Wastes Permits
Wastewater Management Division, Indirect Discharge of Sewage General Permit for Septic Systems
Wastewater Management Division, Concentrated Animal Feeding Operation Permits (pending)
Watershed Management Division, Stormwater Program Multi-Sector General Permit Program

Agency of Agriculture, Food and Markets:

Large Farm Operations
Medium Farm Operations
Accepted Agricultural Practices

Key Regulatory Strategies and Next Steps to Address Excessive Pathogens

The VTDEC and AAFM regulatory programs listed above address the vast majority of point-source pathogens, as such little additional regulation is needed. In order to assure more consistency in the standards for designing wastewater and water systems, the statute provided that all local ordinances and/or bylaws that regulated water and wastewater would be superseded (i.e. no longer in effect) as of July 1,2007. However, despite this Universal Jurisdiction, the following are key next steps.

- The Water Quality Criteria for *E. coli* in surface waters should be modified to reflect current EPA guidance.

- Consider evaluating AAP provisions to make clear manure management expectations for small farms, and possibly include additional management requirements for small farm operations.

- At present, a Concentrated Animal Feeding Operations general permit is in development, which confers regulatory oversight of certain on-farm pathogen-generating activities to the VTDEC. This general permit is being developed under EPA promulgation, in cooperation with AAFM.

Funding programs to address Excessive Pathogens

Department of Environmental Conservation:
Clean Water State Revolving Fund
Clean Water Act §319 Implementation Funding
Ecosystem Restoration Program Ecosystem Restoration Grants
Watershed Grants (jointly administered with Department of Fish and Wildlife)

Agency of Agriculture, Food, and Markets:
Best Management Practice (BMP) Program
Alternative Manure Management (AMM) Program
Nutrient Management Plan Incentive Grants (NMPIG) Program

Natural Resources Conservation Service:
Conservation Reserve Enhancement Program
Environmental Quality Incentives Program

Lake Champlain Basin Program:
Technical program grants
Local implementation grants

Key Funding Strategies and Next Steps to Address Pathogens

The Clean Water State Revolving Fund (CWSRF) is a major funding source for wastewater infrastructure. It is designed with a priority system to ensure that the most important remaining point-sources are addressed earliest, and the technical assistance provided by the Wastewater Management Division programs listed identify facilities in need of upgrading. As of 2009, the priority system established within the SRF may earmark up to 20% of funding for Green Infrastructure/Low Impact Development funding. In order to maximize the nutrient reductions achievable through the SRF, funding algorithms may need to be modified in order to give more weight to stormwater management projects, which currently tend not to score well when compared to wastewater projects. Incentives could be provided in the form of lower interest charges on loans to promote increased use of SRF for stormwater infrastructure improvement.

For agriculture sources, improved manure storage and management are critical. The two primary sources of funding for manure management systems are NRCS' EQIP program the AAFM's BMP program. Both programs offer cost-share assistance (generally 75-90%) to producers to support construction. Participation in both programs is voluntary. As a result, cost-share assistance tends to be biased towards producers who have pro-actively sought help from one or both funding agency(s), as opposed to the environmental risk/need associated with the operation. To maximize the environmental gains through these programs, it will be important to shift toward a model that involves more pro-active outreach to farmers. It is believed that the new extension agents will help in this regard, and AAFM has re-directed a portion of their Agricultural Resource Specialists time to identifying and prioritizing problem areas on small farms and connecting producers with implementation resources. ANR is also working with NRCS to establish a "showcase watershed" in Vermont, similar to a current effort in the Chesapeake Bay watershed; one component of such a program would be pro-active outreach to all producers within the basin.

Information and education programs to address Excessive Pathogens

Department of Environmental Conservation
Watershed Management Division, Lakes and Ponds Section – Lake Protection Series

Other
UVM Sea Grant Programs
Lawn to Lake group, "Don't P on your Lawn" campaign
Various short term programs through NGOs and watershed groups

Key Education and Outreach Strategies and Next Steps to Address Excessive Pathogens

Given the very stringent state standard for *E. coli* (77 colonies forming units per 100 milliliters), many public swimming area administrators are unsure of the proper protocol as to limit public access for water recreation when sample analysis exceeds the state standard. Inaccurate public opinions as to the suitability of swimming waters results. There exists a continuing need to improve public understanding of health issues related to water recreation and drinking water.

The Natural Resources Conservation Districts, in partnership AAFM and NRCS carry out the majority of educational efforts for agricultural lands.

In urbanized settings, education is limited geographically and varies in effectiveness. A small scale effort is provided by a loose partnership of non-governmental entities and DEC with limited funding from the Lake Champlain Basin Program, and educational efforts by watershed groups and others are funded through various grants. The current approach is piecemeal and would benefit from adequate resource support for developing and implementing a social marketing campaign to encourage adoption of residential BMPs (such as the "Poop the Scoop" campaign). Campaigns that are effective and far reaching require more funds then are available through current grant programs. Needless to say, additional sources of funds would be required to continually support these types of campaigns.

Towns and other entities subject to MS4 stormwater permitting develop and distribute education about the source of stormwater and residential BMPs for protecting surface waters from stormwater. To meet permit criteria, they provide information on websites, displays, commercials, and factsheets. In municipalities subject to mandatory stormwater pollution control efforts at the individual parcel level (e.g., where total maximum daily loads and residual designation authority has been imposed), considerable education and outreach effort is provided to residents on how to comply with the stormwater control requirements. Materials developed for that purpose should be made available to residents and officials in other municipalities, coincident with a coordinated outreach effort.

Further, WSMD staff could assist DEC's Environmental Assistance Program in encouraging businesses to implement water quality protection BMPs or meet municipal compliance in MS4 communities